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REPORT

OF

PROFESSOR GEORGE H. COOK

UPON THE

Geological Survey of New Jersey,

AND

ITS PROGRESS DURING THE YEAR 1863.

TRENTON, N. J.:
PRINTED BY DAVID NAAR, "TRUE AMERICAN" OFFICE.
1864.

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READ BEFORE THE SENATE, AND ORDERED TO BE PRINTED.

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REPORT.

The Report which I have the honor to read before this body, is upon the Geological Survey of New Jersey, and its progress during the year 1863.

The account may be divided into two parts. 1st, A sketch of the surveys made previous to 1863. 2d, A report upon the progress of the work during the last year.

The geology and mineralogy of New Jersey, have attracted attention from its earliest settlement. Its ores of iron, copper and zinc have long been objects of laborious and expensive, if not systematic exploration. Iron was made in Morris County shortly after the year 1700, and in Monmouth before 1720. The copper mines of Belleville were discovered in 1719, and those at New Brunswick in 1748. The ores of zinc were discovered very early, but for a long time could not be successfully worked.

Appreciating the importance of an accurate knowledge of the natural resources of the State, the Legislature of 1835, authorized a Geological Survey to be made, and under this authority, Prof. Henry D. Rogers, then of the University of Pennsylvania, and now Professor of Geology in the University of Glasgow, Scotland, was appointed Geologist. He made a partial report upon his work, which was printed in 1836; and then a final report in 1837, which however was not published until 1840. This report was in an octavo volume of three hundred and one pages, and was accompanied by a geological map of the State, and several geological sections. This was a very able report; it sketched in a masterly manner the geological features and did justice in its descriptions to the rich and abundant agricultural and mineralogical resources of the State. For the time and and means expended, this was a most profitable work for New Jersey; and in the highest degree creditable to its distinguished author. At that date, it was undoubtedly the best of the series of reports which had been published upon the geology of the different States of our Union.

With the increasing development of the wealth of New Jersey, there arose a want of fuller and more detailed information in regard to its various soils, rocks, ores, limestones, building materials, fertilizers, and other useful natural products; and in 1854, the Legislature

authorized another and much more extended survey to be made. This survey was placed under the direction of Dr. William Kitchell, as superintendent, and the work of constructing a topographical map of each county in the State, upon a large scale, was immediately commenced. The collection of data for delineating upon the surface of the map the location of various kinds of rock, mines, marl-beds, &c., and for making a full report, was also commenced at the same time.

The progress of the survey in its several departments, during that year, was reported in a volume of one hundred pages, to the Legislature. In 1855, the work was urged forward under the same organization, and a report upon the work was made in a volume of two hundred and forty-eight pages, with many illustrations. The work was continued but with somewhat diminished force through 1856, and a third report upon the progress of the survey was made in a volume of seventy-nine pages, when, owing to a failure of means to carry out the work upon the scale on which it had been projected, it was suspended. The map of the County of Cape May had been engraved and printed. The map of Sussex was nearly all engraved, Monmouth was surveyed and the map drawn ready for the engraver, and several other counties were partly surveyed, when the work upon them was stopped. The geological survey of Cape May was completed and published; the materials for the reports upon Sussex and Monmouth were to a great extent collected, though not written out, and others were in an advanced state of forwardness at that time. Upwards of eighty iron mines were said by Dr. Kitchell, to have been enumerated and described. A large number of chemical analyses had been made, and geological specimens, minerals and fossils, had been accumulated in great quantities. Preparations had been made on an extended scale for a work which, when completed, should be a monument to the enterprise of the State, and a fitting exponent of her unequalled advantages in resources and location. To all concerned in this important State work, either as projectors or prosecutors of the survey, this suspension was a subject of mortification and deep regret. With only a mass of unfinished work, and unarranged materials to show for the great expense incurred, the labor of years seemed thrown away, and all who had been connected with the work were more or less discredited.

Dr. Kitchell, as superintendent, in particular felt that an injury was done to his scientific reputation in thus summarily closing the work in which his highest aspirations had been centered; and despairing of seeing it revived by the authority of the State, he, in 1860, came forward under the auspices of the State Agricultural Society, and offered to complete and publish at his own expense, a geological report and map of the State, and to find his compensation by the sale of the work; asking only the use of the apparatus and material belonging to the State survey. His offer was accepted, and he received the requisite authority. The completion of a State map was immediately undertaken, and by an arrangement with a publisher in

Philadelphia, it was issued the same year. The map is before you, it is an excellent one. Drawn to a scale of two and a half miles to one inch, it is large enough to show all the roads in the State, all the prominent physical features, as the mountains, rivers, &c., and in all except towns and villages, the locations of the dwellings are shown. It has only been offered for sale in a part of the counties, but wherever offered it has met a ready sale.

Dr. Kitchell's labors were suddenly terminated by his death, about the close of 1861. It is to be regretted that he did not survive to complete the work in which he had shown so deep and abiding an interest; and to fulfil the high expectations which a large and affectionate circle of friends had centered in him. The results of his efforts must be found in the published reports and map; and in such portions of his notes as may yet be used in preparing a final report.

During the progress of the survey in 1854, '55 and '56, I held the appointment of Assistant Geologist, and had charge of the geology of the southern portion of the State. After the death of the late Superintendent, I felt that it devolved upon me to see that a work of so much public importance was not entirely abandoned; and the State Agricultural Society, at my suggestion, requested and obtained from the last Legislature an act authorizing me to finish the survey on the same terms that were granted to Dr. Kitchell.

2. I have prosecuted the work during the past season as rapidly as the means and time at my disposal would permit. In all that has been done my object has been to survey and define, accurately, the great geological formations of the State and their relations to each other. To properly construct a frame-work, about which the facts and minutia of the survey may be systematically arranged as fast as they are collected. For this purpose a section has been surveyed across the State, from the mouth of Shark River Inlet, on the Atlantic shore, to the Delaware Water Gap. This section has the advantage of crossing all the principal geological formations of New Jersey, and by extending it on to Scranton, in Pennsylvania, it crosses nearly all the formations of the United States.

Beginning at the southeast extremity we have:

1. The drifting beach sands, piled up in hillocks on the immediate margin of the ocean. These are now in process of formation; and on this section occupy only a few hundred yards in width.

2. Sand, clay and gravel deposits, with a moderately undulating surface. They are represented as extending from the beach up to near Poplar, about two miles. This is probably of the Tertiary Age, though it is without fossils.

3. A bed of green sand or marl. This extends through Deal and Poplar, about three miles across, and is of the older Tertiary Age. Like the other beds of green sand, it is remarkable for its fertilizing qualities.

4. Beds of sand, clay and green sand or marl. These are of the

Cretaceous Age, and the belt they occupy is about twelve miles wide, extending from below Eatontown to near Middletown Point.

5. Beds of sand, and of spurious marl, containing some green sand and much iron pyrites and sulphate of iron in a dark, astringent clay. This, too, is of the Cretaceous Age. It is met with from Middletown Point to the head of Cheesequakes Creek, a distance of about five miles.

6. Deposits of potters' clay, fire clay and fire sand are next met with in regular beds. The Amboy and Woodbridge clays are of this deposit. On the section this extends from the head of Cheesequakes Creek to Lawrence's Brook, below New Brunswick, a distance of six miles. This is the lowest of our Cretaceous formations.

All the formations thus far are very regular and uniform in their position, all in regular and continuous layers, inclining towards the southeast, with a descent of about thirty feet to the mile.

7. The *Red Shale* and *Red Sandstone*, which constitute the rocks of the country on this section, from below New Brunswick to Lebanon, in Hunterdon county, which is twenty-five miles. This well known rock is remarkable for having all its layers descending gently towards the northwest. It belongs, probably, to the Triassic Age.

8. Gneiss Rocks. These rocks are stratified, but in layers which are almost vertical. The Schooley's Mountain range is of this kind. The section crosses this rock from Lebanon to Hampton—and also in the two ridges on either side of Oxford Furnace—a distance of thirteen miles. The *iron mine* near High Bridge, and those at Oxford Furnace, are in this rock and crossed by the section. Layers of white limestone are also found in this rock. One is crossed near Oxford. This rock is of the Azoic Age.

9. Sandstone. This is a thin layer of rock lying upon the gneiss. It is known in New York as the Potsdam Sandstone. It is only a few feet in thickness. It is of the Silurian Age.

10. Limestone. This rock is crossed in the valleys of the Musconetcong, the Pohatcong, the Pequest, and the Paulinskill, the extremes of which points are fifteen miles apart. It is everywhere the basis of a fruitful soil. It is of the Silurian Age, and is known as the Black River and Trenton Limestone.

11. Slate. This is the rock in which the slate quarries near the Water Gap are worked, and it is the basis of the soil in the rich dairy districts of Sussex and Warren. It is known in New York as the Hudson River Slate, and is Silurian in Age.

12. Conglomerate. This is the rock of the Blue Mountain and the Water Gap. It forms a prominent feature upon the surface of the State. It is frequently called the Shawanqunk Conglomerate, and it is of the Silurian Age.

13. Red and Gray Sandstones. These are upon the northwest slope of the Blue Mountain, and their character is indicated by the name. The name Medina Sandstone is applied to it by the New York geologists. It also is Silurian.

In all these, from the Red Sandstone the rock is undulating or in folds, with a prevailing descent to the southwest. Here we pass out of the State and into Pennsylvania. But farther up the Delaware in New Jersey, other rocks are found as the Lower and Upper Helderberg Limestones; the Marcellus Shales; the Oriskany Sandstone, &c. If we pursue the direction of the section across into Pennsylvania, we cross these rocks in succession, and finally reach the coal at Scranton. The coal formation is geologically the rock next older than our red shales and sandstones.

In the collection of these details I have aimed to ascertain, describe, and sketch such localities as can easily be referred to by any one interested to verify them, or by any students of geology who may wish to visit localities where are exhibited, the truths which are recorded in our books. The accompanying section on a horizontal scale of one mile to an inch, and a vertical scale of two hundred feet to the inch, exhibits the principal results of the work upon it. Where more minute details seemed desirable, I have made sections of small parts of this upon an enlarged scale. Here are a number of such relating to the marl deposits, the red sandstone and trap rocks, and to the limestone and gneiss formations.

With a sufficient variety of these, I have endeavored to make plain and indeed to demonstrate a number of points which were not clearly settled in the first survey. Thus the commonly received opinion that the white limestone of Sussex is the same as the blue limestone only changed in color and structure by heat, is clearly shown to be erroneous by the sketch of a locality near Franklin Furnace, where the two rocks are seen to be totally distinct from each other, one of them being in layers which dip to the southeast, while the other lies upon the upturned edges of the former and dips to the northwest.

The Green Pond Mountain, that long, narrow and singularly unbroken ridge, formerly supposed to be of the age of the red shale and red sandstone, now proves to be of the silurian age, having the common Trenton limestone fossils upon one side, and a non-fossiliferous blue limestone upon the other.

The next step in the survey will be to trace out and describe the lines of meeting of the different formations by following them in a northeast and southwest direction entirely across the State, taking note of their peculiarities, and of everything that appears to be of moment.

Next will follow the collecting and describing of soils, rocks, minerals, building materials, fertilizers and other useful substances which may be met with. Something has already been done in this, but the labor required for it is so different from that needed in the work of exploration, that it is found easier to take the two parts separately.

The chemistry of geology is of vast importance, and is a subject of continual study. A large number of unpublished analyses of marls and limestones, iron ores and rocks are already finished.

The next and final business must be to arrange systematically the material which has been collected, and prepare it, with proper maps and illustrations for publication.

The importance of having this work so executed and published that all our citizens may understand the geology of the State can hardly be over estimated. To the practical man it is of the first importance to *know* that the materials of the globe are not jumbled together in a confused mass, where any particular substance can be found only by chance, but that there is an orderly arrangement of them, and each is to be found in its appropriate place. The soils upon each rock formation have their peculiar characteristics, and the farmer who wishes to devote himself to dairying, to the raising of stock, of grass, of grain, of fruits or of garden vegetables, will look for the rock formation and soil upon which his special product is most profitably raised. Our iron need only be looked for in one kind of rock, and that rock is confined to a particular district of country. The limestones are all in regular layers, traversing the country in a northeast and southwest direction, and never in any other. Our green-sand marls are only found in one favored portion of the State. The fire-clays are only in one belt of country which crosses the middle of the State from the northeast to the southwest. It would be worse than useless to look for magnetic iron in southern New Jersey, marl in the northern part of the State, or coal beds anywhere within our bounds.

It is only by surveys of this kind carefully carried out over the whole country, faithfully described and illustrated, and the results brought within the reach of all our citizens, that we can fully and profitably make this arrangement known and appreciated.

Our abundant but undeveloped resources require from the State this kind of survey and publication.

The United States Census Report, states that we have 5,324,800 acres of land within the bounds of the State of New Jersey. Of these, 2,984,531 acres are returned as constituting the improved and unimproved lands that are in farms; and the remaining 2,340,296 acres are not connected with any farm improvement whatever. Much of this wild land is no poorer than other land which is in a good state of cultivation. It is in the same geological formation, of the same general quality, spots of it which are cultivated produce crops, and it only needs to be put into the hands of enterprizing and skillful farmers to place it on a par with other productive land of the State.

The iron ores in the northern part of the State are capable of being greatly extended in their workings. Dr. Kitchell estimated that they were capable of yielding a million tons of ore a year, which is at least five times as much as they now yield.

Our clay-pits and our marl-beds are only beginning to yield the riches which they contain.

This is the condition of our resources now, and yet if we look back ten years, and see the progress which has been made, and then com-

pare it with the progress in neighboring States, we shall find reason for congratulation.

1. A comparison of the cash values of farms per acre, in 1850 and in 1860.

	1850.	1860.	Gain per acre.
New Jersey,	$43.67	$60.40	$16.73
New York,	29.00	38.00	9.00
Pennsylvania,	27.33	39.00	11.67
Delaware,	19.75	31.00	11.25
Connecticut,	30.50	36.00	5.50
Rhode Island,	30.82	37.00	6.18
Massachusetts,	32.50	34.00	1.50

The returns show 230,000 acres of land in farms in 1860, above the number in 1850. This is not materially different from rate of increase in the other States.

2. In mining iron ore, it was thought in 1855, that there might be mined in all New Jersey, 100,000 tons of ore a year. This year the Morris Canal has carried 176,531 tons of ore, and a large quantity in addition has been carried over the Central and Warren Railroads, enough in the aggregate to amount to 200,000 tons. A large quantity in addition has been consumed in forges and furnaces not reached by canal or railroad.

3. The business of transporting marl to comparatively distant points, had hardly commenced at that time. This year the Freehold and Jamesburg Railroad has transported 12,130 tons of Squankum marl and distributed it over a country from seven to twenty miles away from the pits. The Burlington County Railroad, has, within the last eight months taken from Pemberton, 15,000 tons of marl, which have been distributed along the line of that road, the Camden and Amboy Railroad, the Delaware and Raritan Canal, and in Pennsylvania; and the annual demand upon these lines will fall but little if any short of 50,000 tons a year.

The West Jersey Railroad has commenced the transportation of marl to the country along the line of that road, and of the Millville and Cape May roads, and the demand is such as to warrant them in preparing for an annual sale of 100,000 tons. In a very short time they will be prepared to supply that amount.

The Raritan and Delaware Bay Railroad has carried 6,037 tons of marl for use upon the farms along its line, and the want of transportation has hindered it from doing much more.

The Camden and Atlantic Railroad is also engaged in transporting marl, though I am not furnished with statistics of the extent of the trade.

These only show the extension of the use of marl in districts where it would not be profitable to transport it by teams. The great con-

sumption still is in the vicinity where it is dug. 10,000 tons have been taken from a single pit by teams in a year.

The work of collecting fertilizing materials from the waters of the Atlantic and of Delaware Bay is carried on to some extent. From 300 to 500 tons of a concentrated manure prepared from king-crabs, and worth about half as much as Peruvian guano, are annually prepared on the Bay shore of Cape May. And a commencement has been made in preparing a manure from the fish which abound in our bays and sounds. I have no account of the extent of this useful work, but am confident that it is only the beginning of what will prove an important branch of industry, and furnish a full substitute for all the guano that is needed in the State.

But the field for the development of our natural resources is still very large, and it becomes us, both by publishing and giving direction to capital and energies at home, to aid in carrying it forward.

The publication, either by other parties or by those controlled by a narrow interest, is always incomplete. The United States Census Report credits us with 57,800 tons of iron ore, instead of our present 200,000 tons. And our zinc ores, amounting to from 10,000 to 15,000 tons a year, are not even mentioned. And some other branches of industry are in the same condition.

Again, our iron ores are mostly carried out of the State to be worked—carried westward into Pennsylvania—and when worked the iron is brought east to New York, passing directly by the mouths of the mines from which it was first taken. The coal used in manufacturing iron could as cheaply be brought to the ore as to carry the ore to the coal; a long double transportation would be saved, and our farmers and mechanics benefitted by the home market thus created. Should not every effort be made to restore these manufactures to their proper locations?

And in general, with lands as productive as the virgin soils of the West, and the best markets on the continent at our very doors; with mines of iron and other useful metals, rich and abundant, and with every facility and stimulus for increasing our material wealth, we have still vast stores of undeveloped riches; riches awaiting the hand of the diligent, and only needing to be known to be appreciated.

With the value of our farm lands increased $40,000,000 in ten years, and a like rapid improvement in the value of farm implements, of live stock, of farm and garden products, we may well feel satisfied with the progress of New Jersey in the accumulation of physical comforts. And when we consider that the addition is nearly twice as great as in the neighboring States, difference in size being allowed for, we very naturally inquire for its causes. Has the geological survey had any agency in it? Ten years ago it was commenced; imperfectly as it was carried out, and incompletely as its results were published, I know individual cases of rise in value from its investigations which are more than equal to its whole cost. And taking all

its results into account, I cannot but think the money expended in it has been one of the best investments ever made by the State.

To draw from the survey the fullest practical results, a few facts and suggestions are here offered in the hope of calling out inquiry and awakening interest throughout the State. A very large and important part of the survey must be to collect from intelligent and observing men the facts which have come within their knowledge, and as completely as possible arrange and combine these in a general system from which other and important conclusions and inferences may be drawn; and correspondence and inquiries relating to them and to similar subjects are invited from persons interested in them.

LEAD ORES.—A lead mine of extraordinary richness has been discovered within the last two years, upon the northwestern slope of the Blue Mountain, a few miles beyond our northern boundary. It is upon the range, and in the same rock with the lead mines at Wurtzboro' and Ellenville. The first indications of it were found in masses of lead ore lying loose upon the surface where the mine is now opened. As the same rock is found in New Jersey from near Port Jervis down to the Water Gap, it is possible that other veins of the ore may be found in our State, and the surface should be carefully examined for that end.

ZINC ORES.—In Sussex County at Franklin Furnace, and at Sterling Hill, there are immense beds of zinc ore. The ore is of a kind found no where else in any quantity. From ten to fifteen thousand tons of the ore from these mines are consumed every year in the manufacture of white paint. Recently the manufacture of the metal itself from these ores has been successfully commenced. The only other zinc mines at present worked to any extent in our country are near Bethlehem, in Pennsylvania. An inspection of the map shows that the same geological formation extends from one mine to the other. The ore found at Bethlehem is a hydrous silicate, and ore of the same kind is found in small quantity at Sterling Hill. Other mines are looked for in the range between the two places. As the supply of this metal is not at all equal to the demand, it becomes an object of public importance to increase the manufacture. The ore has not a metallic appearance, but resembles a drab colored limestone. It is easily recognized by the white smoke which it gives off when pulverized and thrown upon a very hot coal fire.

IRON ORES.—The iron ores of New Jersey are an unfailing source of wealth to the State. They occur in beds which stand nearly vertical, and interposed between the layers of gneiss rock. They descend between these layers towards the northeast, and when followed in that direction beneath the surface they hold their full size and thickness as far down as they have been worked. The general structure as well as the peculiarities of this system of beds of magnetic iron ore,

must be the subject of patient and laborious examination. It is specially desired to collect further facts in relation to the folding or doubling of the beds, the thinning out of beds and the commencement of others parallel to them, their peculiar effects upon the magnetic needle, &c.

WHITE LIMESTONE.—In addition to the white limestone which is found all along the northwest border of the gneiss rocks, from the northern line of the State down to the Delaware, detached beds of a white limestone containing serpentine have been found in the valleys between the ridges of gneiss, at Winoke above Pompton, at Montville, at Mr. Sander's farm, four miles west of Morristown, at Lamington Falls, near the head of Lake Hopatkong, and it is said to be found on the Pequanock, a few miles above Bloomingdale. These beds are of much value to the country in their vicinities, and some of them will be of still more importance from their nearness to canal or railroad transportation.

BLUE LIMESTONES.—On the eastern side of the rock of the Green Pond Mountain, good limestone is found, at West Milford, at Mockapin, and then at the middle forge, above Rockaway. The same bed must exist throughout the whole distance, and quarries of limestone may be looked for anywhere on the range between the two places.

In regard to the limestones of the State, it becomes an interesting inquiry as to the relative values of those which are nearly pure compared with those which are partly composed of magnesia. The limestones of the Paulinskill, Pequest, Pohatcong and Musconnetcong valleys, and those of Clinton and Peapack, are magnesian; and so is much of the lime brought into the State from Pennsylvania. Lime from northwest of the Blue Mountain, that from the yellow limestone of the marl region, that from oyster shells and that from stone quarried at Rondout, is comparatively pure lime. Which is the best for agricultural purposes, or for building, or for use in blast furnaces?

FIRE CLAY.—This clay, which is largely dug at Woodbridge, South Amboy and at Trenton, is of much importance to the industrial interests of the State. It is used in making fire-brick, and already it has driven foreign bricks from the market, and has supplied their place at about half their cost. New localities of this substance may be looked for at other localities in the central part of the State.

CALCAREOUS MARL.—Calcareous or shell marl, similar to that found in the southern States, occurs in many places along the shore of the Atlantic and Delaware Bay at heights of from one to ten feet above high water mark. It is a valuable fertilizer, and all accessible localities should be known.

COPPER ORE.—Copper mining has not heretofore been found profitable in our State, but the large sums of money which have been spent in the business make it of general importance. A full collection of facts relating to all the localities where copper has been noticed, or mining enterprises undertaken, might, when compared with each other do something to either discourage or else to give intelligent direction to this branch of industry.

THE

ANNUAL REPORT

OF

Prof. Geo. H. Cook, State Geologist,

TO

HIS EXCELLENCY JOEL PARKER,

PRESIDENT OF THE BOARD OF MANAGERS

OF THE

GEOLOGICAL SURVEY OF NEW JERSEY,

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REPORT.

To His Excellency Joel Parker, President of the Board of Managers of the Geological Survey of New Jersey:

SIR:—I have the honor to report that in accordance with the plan submitted to you at the meeting in May last, the work upon the Geological Survey was resumed on the opening of spring, and has been steadily prosecuted since.

Mr. John C. Smock, who was appointed Assistant Geologist, has been constantly engaged in tracing out the boundaries of the rock formations in the northern part of the State. He has but just closed his field-work for the season, and has not been able to write out the results of his work for this report. The writing out of his notes in full, and recording his observations, together with chemical examinations of various specimens collected in his summer's work, will keep him profitably employed during the winter. The pains-taking labor which he has performed will be appreciated when the final results are published.

Major T. B. Brooks, who was connected with the Topographical Survey of Sussex County, has been engaged for a part of the time since September first, in a magnetic survey of the iron ore district. He has already made a pretty full survey of the Ringwood mines, and is now engaged among the well-known iron mines of Morris County. His work is not yet mapped out, but it gives promise of adding valuable knowledge to that already known of our important iron mines.

Prof. David Murray has spent some time during the summer in arranging the materials we already possess and commencing the projection of a map of the State. The scale adopted is two miles to an inch. This work will be carried forward as the Survey advances, and, I trust, will be ready by the time the Survey is done.

Mr. Charles C. Abbott has voluntarily devoted himself to the preparation of annotated catalogues of the vertebrate animals of the State. He has already completed that of the birds, and has made considerable progress with that of the reptiles. These catalogues will make an interesting feature in our Natural History.

Prof. D. T. Reiley has given his services in the collection of suites of the minerals found about the zinc mines in Sussex. This collection contains some rare and valuable specimens, and is the beginning of the series of collections which must be made to illustrate all the important localities in the State.

It will be remembered, that, in consideration of the small amount of money appropriated to the Survey, and the magnitude of its work, the Board authorized me to ask from the several railroad companies of the State, free tickets for myself and assistants while in the prosecution of the Survey; and also that they furnish such information from their surveys as may be properly used in the construction of maps and profiles. I take pleasure in reporting that we have received free tickets on the Camden and Amboy, the New Jersey, the Central, the Warren, the Morris and Essex, the Sussex, the New York and Erie, the West Jersey and its connecting roads, the Camden and Atlantic, and the Raritan and Delaware Bay Railroads.

The United States Coast Survey and the Smithsonian Institution have proffered valuable material and aid for the completion and publication of the Survey. And gentlemen in all parts of the State have, with a most hearty interest in our work, given information and assistance such as could not have been worked out without a heavy expense in time and money. In

fact, the results of the Survey will, to a great extent, consist of knowledge obtained from different individuals.

Information in regard to the geological and other resources of the State has been sought by parties interested, and wherever it could be given without detriment to the work in progress, it has been done, with the understanding, in all cases, that whatever facts are ascertained must be public, and used in the prosecution and publication of the final report. It is a satisfaction to know that information communicated in this way has been made useful.

The last report gave an enumeration of the several geological formations of the State, with references to a section which had been made across them from Shark River Inlet, on the Atlantic shore, in Monmouth County, to the Delaware Water Gap, in Warren County. This year a considerable part of the work has been in defining the outlines of these formations, as they exhibit themselves in belts of greater or less width, extending across the country from the northeast to the southwest. The line between the red sandstone and the gneiss and white clays has been traced, as heretofore, in a nearly direct course from Trenton to the Raritan River, a little below the mouth of Lawrence's Brook. North of the Raritan the line is exceedingly crooked and obscure to Staten Island Sound, near Woodbridge. On Staten Island it crosses almost straight from Fresh Kills to Port Richmond. In New York Bay the line passes near and to the west of Robins' Reef, Oyster Island, Bedloe's Island, and Ellis Island. It then passes back of Jersey City and Hoboken to the North River, below Weehawken.

The gneiss rock which once formed the southeastern boundary of the red sandstone across the State, has been decomposed almost entirely, and its place is now marked by the white clays which have originated from the decomposition of its feldspar. In places where the rock is yet found, as at Trenton, it can be seen with this process of decomposition only part

completed. The gneiss rock itself can be seen at Trenton, on this line, for two or three miles. Northeast of this, it is not seen again until Staten Island is crossed, where it appears just at the Quarantine Landing. It is next seen in some of the low grounds near the river bank in Jersey City. Next it is found on New York Island, about Fortieth Street.

There can be little doubt that this narrow ridge of rock has, at some time, formed the western bank of the North River from Jersey City down to Robins' Reef. There are now three Islands between these two points, viz: Ellis', Bedloe's, and Oyster Islands, and the water between them is shallow and the bottom hard and without mud. Oyster Island, which is seen only at low water, and Robins' Reef, which is seldom bare, still have in their soil the roots of trees, showing that, at no long time since, they supported a growth of wood, though they are now five or six feet below high water mark. The bay, which is to the west of this line, is mostly filled with mud like that now found in the salt marsh. And along the shores, in some places, meadow sod is found under the mud, and much below high water mark. The grounds along the shore have been encroached upon in some places by the tide water. At Caven Point, it is said, that several years ago three acres of upland were washed away within two years. All the circumstances, connected with this bay, point to the conclusion that it has once been a tide meadow, with channels of deep water traversing it in various directions, and having in it low knolls of upland, which are now only marked by rocks and hard ground at the bottom of the water.

The Serpentine rock, which is found at Hoboken, and also on Staten Island, is, without doubt, directly upon the northwest side of the gneiss and adjoining the sandstone, though no place is known where they can be seen in immediate contact.

The northwest boundary of the Red Sandstone is defined by a line starting from the Delaware River at the ferry six miles above Milford, and following a direct line to Little York, and

on within a mile of Clinton; there it makes a detour south by Allertown, and around by the Round Valley Brook to Lebanon. From Lebanon the line is quite direct to Peapack, and almost to Mendham. Thence the line returns and passes around Mine Mountain and along its southerly foot near Basking Ridge, New Vernon and Morristown. There are immense deposits of gravel and earth covering the rocks, so that the line cannot be traced with any accuracy from Morristown to the Rockaway River, near Old Boonton, where the sandstone is seen in the bed of the river. It can be seen again at Montville, Pompton, and along the southeast foot of Ramapo Mountain to near Suffern's, which is just beyond the State line in New York.

There is no place on the whole of this line where the red sandstone or conglomerate has been seen in contact with the gneiss or limestone, though they are in many places within a few feet of each other. Such a locality would be exceedingly interesting and instructive.

The tracing of this line is important, for the northwest border of the sandstone, in many places, is made up, to a large extent, of limestone pebbles and boulders, which form a conglomerate, so firm that it can be burned for lime, and it is burned for that purpose at Lebanon, New Germantown and Pompton. This line also meets obliquely several long narrow belts of blue limestone. The limestones at Holland, Little York, Clinton, Allertown, Pottersville, Peapack and Mendham, are examples of these, and are well known by their use in agriculture and in building.

In the red sandstone between Clinton and Clinton Station, on a hill a half mile south of the road between the two places, and on the land of J. T. Leigh, Esq., black oxide of manganese was discovered. An opening had been made, apparently to search for iron ore, and the mineral dug out was left lying upon the ground. It was said to be hematite, but as it bore a strong resemblance to oxide of manganese it was analyzed and proved

to be that substance. The opening appears as if it were upon a vein three or four feet wide, nearly perpendicular, and without any gangue or vein stone. An analysis shows it to contain forty-five per cent. of black oxide of manganese.

Black oxide of manganese is in demand for the manufacture of bleaching powders, and, if sufficiently abundant, would find use in other arts.

The *Limestones* which lie in the valleys of our Highland range of mountains, along Peapack Brook and the South Branch, Musconetcong, Pohatcong, Pequest and Paulins Kill streams, have been carefully traced out in their boundaries, and the different varieties of pure limestone, magnesian limestone, and cement, to some extent studied, and their order of arrangement determined. The magnesian limestone has been the one chiefly burned for lime heretofore, but a fossiliferous limestone, which is almost free from magnesia, is to be found at several localities in Sussex and Warren Counties. The only place where it is now burned is at the kiln of Mr. A. T. Mains, near Stillwater.

The following analyses will show the difference in composition between this fossiliferous limestone and the magnesian :

Analysis of a Fossiliferous Limestone from the Quarry of J. T. M'Carter, Esq., Newton, Sussex County.

Carbonate of lime, - - - -	87.50
Carbonate of magnesia, - - -	1.98
Alumina and oxide of iron, - -	4.70
Silica and insoluble matter, - -	5.80
	99.98

Analysis of a Magnesian Limestone from the Quarries in Belvidere, Warren County.

Carbonate of lime, - - - -	52.90
Carbonate of magnesia, - - -	42.26
Alumina and oxide of iron, - -	1.40
Silica and insoluble matter, - -	2.90
	99.46

The first of these has not been used for burning into lime. The latter is used in large quantities, and is in good repute.

But pure lime has decided excellences over that containing magnesia, for agricultural and building purposes, and for use as a flux in the manufacture of iron. It swells more in slaking, a smaller dressing is needed for land, it takes less to make mortar, and is usually of a purer white and more suitable for whitewashing.

At Peapack there was a considerable quantity of hydraulic lime burned and ground for use in building the locks of the Morris Canal. It has proved to be of good quality, but on account of location away from lines of canal or railroad, it has not been much sought after. Stone, which will yield a good hydraulic cement, has been found in other places in this formation.

The *Slate* which underlies so large a portion of Sussex and Warren Counties, has been traced out in the numerous and intricate folds by which it is mixed in with the limestone, but the details in regard to this would be out of place here. In addition to the importance of this rock as the basis of a most productive soil, the increased prices of shingles, tin, etc., has drawn attention to it as the source from which to obtain a cheap and durable roofing material. At present it is probably the

most satisfactory roof, for cost and quality, that can be put on a building. There is a large slate quarry at the Delaware Water Gap, Warren County, which has been opened for a good many years, and yields first quality slates. A quarry is also worked at Lafayette, Sussex County, and one is being opened at Hackettstown. The demand for slates is greater than can be supplied with the present scarcity of labor, but the material is in sufficient quantity, and must eventually be wrought.

The *Conglomerate* on the top and west slope of the Blue Mountain, in connection with the *Medina Sandstone* which lies upon and northwest of it, have attracted much attention within the last year or two, on account of a lead mine of extraordinary richness having been opened in this rock three or four miles northeast of the State line in New York. Lead ore is said to have been found in this formation in New Jersey, though there are no mines of that ore in it that are now worked. The district along the whole slope of the mountain should be thoroughly "prospected." A copper mine upon the same westerly slope, in the township of Pahaquarry, has been opened, but is not now worked.

Northwest of the Blue Mountain, in the valley of the Delaware and its branches, the lines of meeting of the sandstones and limestones were being traced out when the snow set in. Though the district is limited in extent, from what is already known it is presumed that all the important members of the Silurian and Devonian, from the *Medina Sandstone* of the former to the *Marcellus Shales* of the latter, will be identified. The sandstones and limestones of this formation furnish an abundance of good building materials, and the limestones, shell-marls, and travertin supply an abundance of the best fertilizers.

The Highland Range of mountains, in which the rich beds of *magnetic iron ore* are found, has been the subject of special examination, with the design of finding some method of search-

ing for the ore which might be uniform and easy in practice, and satisfactory in its results,—one for which such plain directions could be given that persons interested in this region could make searches for themselves.

It is well known that these beds of ore are interposed between the layers or strata of the gneiss rock, and differ from the strata only in that after extending along the surface for from a few feet to many hundred rods, they thin out and are lost:

That like the rock they have a general direction, or *strike*, from northeast to southwest:

That the layers or strata of the rock, and the beds of ore likewise, stand on edge, with an inclination or slant downwards towards the southeast. This inclination is called the *dip* or *underlie*:

That the beds of ore, as they descend beneath the surface, extend farther and farther towards the northeast. This latter direction is locally called the *pitch* of the ore:

That these beds are not uniformly distributed through the gneiss rocks; in some parts they abound, while in others no mines of value have ever been found. The most productive mines as yet worked have been in the central parts of the range, but as the demand for ore increases other mines are being sought for in the less promising districts. Among new ones opened recently are several along the southeast border of the Highland range, and not far from the red sandstone formation. Beginning at the southwest in Hunterdon County, in the township of Bethlehem, near Van Syckel's, there is a mine worked by the Lehigh Valley Iron Company. Only one opening has been made, but a large quantity of ore is exposed in that. Another mine has been opened about two miles west of Walnut Grove, in Morris County. The bed has been uncovered in several places, and shows a thick and continuous mass of ore. It is worked by the Bethlehem Iron Company. About a mile west of the church at Pompton, Passaic County, an iron

mine has been opened by J. H. Jackson, Esq., and a considerable quantity of ore taken out. On the Ramapo Mountain, in the township of Hohokus, Bergen County, about three miles east of Ringwood, a bed of ore has been uncovered at two or three points, but working upon it has not yet commenced.

The magnetic needle, in some form of mounting, has long been used in the search for iron ore, and probably will still continue to be used. The compass, with a dipping needle, is coming into general use for this purpose, and gives satisfaction. A very excellent instrument of this kind has been prepared for the Survey by W. & L. E. Gurley, of Troy, N. Y.

When not affected by local attraction the needle of this instrument is horizontal, but is disturbed by a very slight attraction. In the case of ores which are themselves magnetic, the north or south end of the needle is drawn downwards, according to the polarity of the ore; while those ores which are not themselves magnetic draw down the north end of the needle uniformly. With the instrument held in position, that is, with the box on edge and the needle settled and pointing north and south, the observer can move forward at a moderately slow walk without causing the needle to vibrate, unless it is disturbed by some attraction, when a movement can be seen at once. The usual direction of the beds of ore being from northeast to southwest, the proper method is to traverse the tract under examination in lines running northwest and southeast, so that if any beds of ore are in it they may be detected when the compass crosses them. By repeated crossings some judgment can be formed of the width and length of the bed.

The force with which the needle is drawn downwards is in some proportion to the extent of its movement, but this movement does not indicate the amount of ore, the attraction depending partly on the distance of the ore beneath the surface, and partly on the magnetism of the ore itself, and both these causes are extremely variable.

By the aid of this instrument it is hoped that the beds of ore

now worked can be traced out in their extension on the surface, and in their connection and relation to each other. They can then be laid down upon a map and arranged for the general study and use of all. There is a great amount of local information in regard to our iron mines which, when collected and arranged, will do much towards giving a rational theory of them, and the best modes of working them.

The *Zinc Mines* of Sussex continue to be worked with energy and success, yielding ore enough to supply a large portion of the zinc white used in the United States, and also a considerable amount of metallic zinc. At Franklin Furnace, and at Stirling Hill, the ore occurs in beds similar to those of magnetic iron ore, except that its associated rock is a white limestone instead of gneiss. The zinc ore of the Saucon Valley Mines, near Bethlehem, in Pennsylvania, though in the gneiss region, is found in blue limestone, and has much more the appearance of a deposit in cross and irregular fractures in the rock. The Bethlehem ore is a hydrous silicate, while that of the Sussex mines consists of franklinite, red oxide of zinc, and anhydrous silicate of zinc. It is, however, remarkable, that at the southwest end of the Sterling Hill mine the hydrous silicate of zinc occurs, and under circumstances to favor the opinion that it has been produced by the decomposition of the anhydrous ores, and a re-precipitation in its present form. The Andover iron mines, which are in the range between these two great zinc mines, contained zinc in some of their ores, and it is not unreasonable to look for other mines of zinc in the same range.

The silicate of zinc has no metallic lustre, and some of its varieties might easily be mistaken for limestone. But this, as well as other ores of zinc, can be easily distinguished by the following test: Take an ounce or two of the mineral and crush it to powder, then throw it upon a common blacksmith's fire, and urge the heat by blowing. If it contains zinc a thick

white smoke will rise, and portions of this smoke which condense in the cooler parts of the fire will appear yellow when hot and white when cold.

Black Lead is said to have been found at several localities within the last year or two. One locality was visited. It is upon the land of Mr. Elias Englemann, about a mile and a half northeast of Peapack, in the township of Chester, Morris County. It occurs in the gneiss rock, in a vein which is between four and five feet thick, almost vertical, and with a strike of north seventy degrees east. The mineral is not pure, being mixed with the disintegrated gneiss. It is said to have been traced for several hundred feet upon the surface, but was open in only one place when visited. It could be mined cheaply.

Lead Ore has been mined in considerable quantity by the Sussex Lead Company, at their mine in Newton Township, Sussex County. The ore has not yet been dressed or smelted. The present high prices ot lead have stimulated mining enterprises remarkably. And it is said by those familiar with the subject, that at present prices, and with the best machinery for dressing the ores, those yielding three per cent. of lead will pay the expenses of working.

The *White Limestone* which is found interstratified with the gneiss rock, along the entire northwestern border of the Highland range in Warren and Sussex Counties, is worthy of more attention than it has yet received, as a source of pure lime. It has been burned at Hamburg and at Andover, for some time past, and its use is commencing at a few other places, but not to the extent its qualities would warrant.

Analysis of White Limestone from near Oxford, Warren Co.

Carbonate of lime, - - - -	96.50
Carbonate of magnesia, - - -	1.13
Alumina and oxide of iron, - -	1.30
Insoluble matter, - - - -	.90
	99.83

This was a fine specimen; white, crystalline, and having the characters of good marble. Some of the white limestone is magnesian; the following, from near Ogdensburg, Sussex County, is an example:

Analysis.

Carbonate of lime, - - - -	53.00
Carbonate of magnesia, - - -	42.26
Alumina and oxide of iron, - -	3.50
Insoluble matter, - - - -	.50
	99.26

The *Fire* and *Potters' Clays* of Woodbridge, Amboy and Trenton are rapidly becoming the basis of large and important branches of manufacture. Fire-bricks of the best quality are made in great quantities near the clay pits, and the material is also sent to many other places to be manufactured. At Trenton the manufacture of pottery is conducted on a larger scale than anywhere else in the United States. There are now nine potteries in operation, which employ several hundred workmen, and manufacture crockery of the best quality in all the forms needed for table and toilet use. Another establishment is now in process of erection, which, when completed, will increase the facilities for this branch of manufacture full one-half.

In the Geological Reports of 1854, 1855 and 1856 it was shown that the marl region of the State, which comprises a belt of country from five to fifteen miles wide, and reaching from Raritan Bay and the Atlantic Ocean, on the northeast, to the Delaware River, on the southwest, was a regular geological formation, and that the rich beds of fertilizing material called *marl*, or *greensand*, were in three distinct layers, each from fifteen to thirty feet thick, and extending continuously across the State, parallel to each other and to the whole formation. It was also shown that the general bearing or *strike* of these beds was north fifty-four degrees east, and their *dip* or descent was towards the southeast, at the rate of twenty-five or thirty feet per mile. The pits from which the marl was usually dug were shown to be on the sides of valleys where streams of water had cut down their beds below the level of the country, and left the layer of marl which had been cut across exposed at its edges.

During the last season the West Jersey Marl Company has made a survey of the country from Mullica Hill by Barnsboro' to Blackwoodtown, taking the location and height above tide water of every marl pit at and between the above named places; and the results agree with, and confirm to a remarkable degree, the conclusions which had been stated in the former reports.

The marl continues to be used, and in increasing quantities, in all parts of the State to which it can be cheaply transported, and it is rapidly aiding to bring the most unpromising soils to a high degree of fertility.

The substance in the marl which gives it such remarkable fertilizing properties is phosphoric acid, probably combined with lime. Other constituents add to its value, but in a much smaller degree than this. A large number of analyses of marl have already been published, and many more are now ready, but it is not thought necessary to print them all until the pub-

lication of the Final Report. The following represent the most important varieties:

1. *Analysis of Spurious Marl.*—This was a fair specimen of the mixed greensand and dark-colored clay which is at the base of the greensand formation, and shows itself along the northwest border of the marl region. The specimen analysed was taken from the diggings of the Messrs. Ten Eyck, near Matavan bridge, Middlesex County.

2. *Analysis of Marl from the First Marl Bed.*—This is a characteristic specimen from the lowest well marked stratum of greensand. The localities where it is found are very numerous along the northwestern part of the marl district, but it is most extensively developed in Monmouth County. The specimen analysed was from a marl pit of J. B. Crawford, in Nutswamp, Monmouth County.

3. *Analysis of Marl from the Second Marl Bed.*—This is an average of the greensand in the stratum which traverses the middle of the marl district from the Atlantic to Delaware Bay. The specimen analysed was from the marl pit of R. Dickson, Woodstown, Salem County.

4. *Analysis of Marl from the Third Marl Bed.*—The specimen analysed was from the marl pit of Hugh Hurley, Shark River, Monmouth County, and is an average of the greensand of the stratum which is seen near the southeastern border of this formation from Deal, Monmouth County, to Clementon, Camden County.

	(1.)	(2.)	(3.)	(4.)
Phosphoric Acid,	1.15	1.12	2.65	3.73
Potash	1.54	5.80	6.81	4.98
Lime,	2.52	11.67	1.04	4.15
Magnesia	2.15	1.97	1.81	.47
Oxide of Iron,	31.50	16 93	19.80	18.70
Alumina,	6.00	7.18	8.04	8 18
Silica,	34.50	40.61	49.73	49.68
Sulphuric Acid,	1.27	.70	.11	2.44
Water,	18.80	8.10	8.34	7.37
Carbonic Acid and Loss,		5 92	.....	.....
	99.43	100.00	98.83	99.70

The *Tertiary* and *Post Tertiary* formations, which make up the whole of the State southeast of the marl region, are now justifying the strong and decided representations which were made of their great agricultural worth in the annual reports of 1854, 1855 and 1856. With the construction of the Camden and Atlantic, Delaware and Raritan Bay, and the West Jersey and its branch railroads across them, which brought them in easy communication with markets, they are being rapidly sold off to actual settlers, and the district is filling up as fast as the new States of the West.

The undeveloped resources of New Jersey are immense, and only need to be really understood to be appreciated. Thus we have more than a million acres of good land which are still unoccupied and almost unproductive; and this, too, when the average price of farm land throughout the State is sixty dollars an acre. We have perhaps one hundred thousand acres of wild and unreclaimed meadow which only need the benefit of public attention and combined effort to quadruple their value. There are nearly a million acres of tide marshes that need the benefit of intelligent and well-directed enterprise to reclaim and bring them into agricultural use

Our limestones, the largest source of artificial manures, abundant as they are in quantity, are not alike in quality, and the results of the present year's survey show that the best are not generally known or used. The marls, singularly useful as they have been in changing what was a waste into a fertile soil, still exist in sufficient quantities to enrich all the soils of the State, and need to be generally and well understood in their geological relations, in order to invite their more extensive working and introduction to districts they have not yet reached.* The remarkable facilities we possess for gathering from the sea,

*There has been transported over the Freehold and Jamesburg Agricultural Railroad the last year 13,179 tons of marl; there has been sent by S. R. Gaskill & Sons, of Pemberton, over the Burlington and Mount Holly Railroad, 12,000 tons; and over the Camden and Atlantic Railroad 10,000 tons.

fish and other substances for the richest fertilizers, should be improved. Thos. Beesley, Esq., of Goshen, informs me that at a single establishment in Goshen, Cape May County, four hundred tons of *Cancerine* have been made and sold the past season. This fertilizer is composed entirely of king-crabs, dried and ground. It is worth about half as much as Peruvian guano.

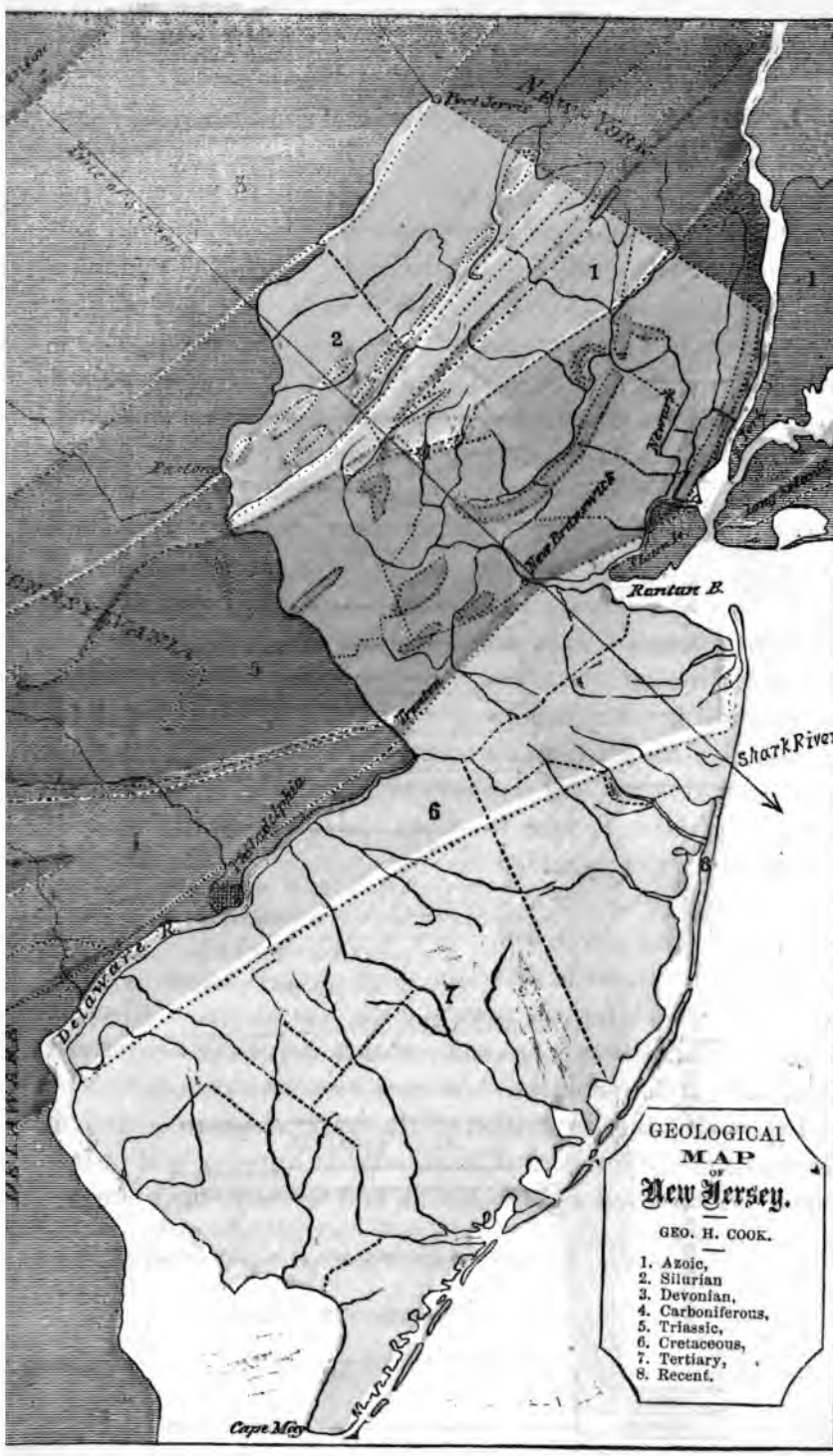
To the mining industry of the State the development of our resources is not less interesting than to the agricultural. Our rich mines of iron ore are yielding large and increasing returns every year. The President of the Morris Canal Company, W. H. Talcott, Esq., furnishes the following:—The amount of iron ore transported on their canal this year is 206,512 tons, against 176,531 tons in 1863. There are 20,000 or more tons mined besides the above, which finds its way to market by railroad or by teams. The price of ore this year, on the canal bank, is seven dollars a ton. There is as yet no systematic search for new mines carried on, and there is no such description of the occurrence of the ore as can become a guide for the mining engineer in economically opening and working new mines. Such a description is due to the heavy interests involved, and would do much to economise and extend our mining enterprises.

The same remarks apply to our zinc mines. In the copper mines there is still more necessity for the fullest examination, and the most careful description and publication. The localities in which copper ore appears are very numerous, and many mining enterprises have been undertaken, in nearly all of which ore was found, and yet the working has been generally unprofitable. It is to the interest of the State to have these mines and works so fully described that mining capitalists may be properly warned of the difficulties they present, and encouraged in what is of substantial value, in them. With the high price of copper, and greatly improved processes in reducing its ores, the mines at Belleville, and some others, are now successfully worked.

The topography of the State should be more perfectly laid down and described. Accurate maps aid wonderfully in studying the capabilities of a country for drainage, for supplying water, for projecting and carrying out works of internal improvement, and for selecting locations for important manufacturing enterprises. The water power in the streams of New Jersey has been a source of great wealth to the State. Paterson, Millville, Bridgeton, and many other places, owe almost their existence to power derived from the streams upon which they are built. At the very door of the best markets on the continent, in close proximity to inexhaustible mines of coal, with a soil from which to raise abundant and cheap supplies, and with the State traversed by great lines of railroad and canal, we possess unequaled advantages for the location of manufacturing towns. Take the Delaware River as a source of power for driving machinery. Its volume of water is immense even in the dryest weather,—greater by far than the Merrimac at Lowell. Its fall from Port Jervis to Trenton is not less than four hundred feet. "From the South Mountain below Easton to the tide-water at Trenton the river has a southwest course of about sixty miles, in which there are twenty-five noted rapids, with an aggregate fall of one hundred and sixty-five feet."—(*Gordon.*) The power which is here lying idle would, if improved, be sufficient to drive the machinery of a Lowell every ten miles, would furnish profitable investment for millions of capital, and create a large and constant home market for our farm and garden products.

I trust that this exposition of the work in progress, and of the value of the interests it is intended to develop, will be acceptable to yourself and the Board, and useful to the State.

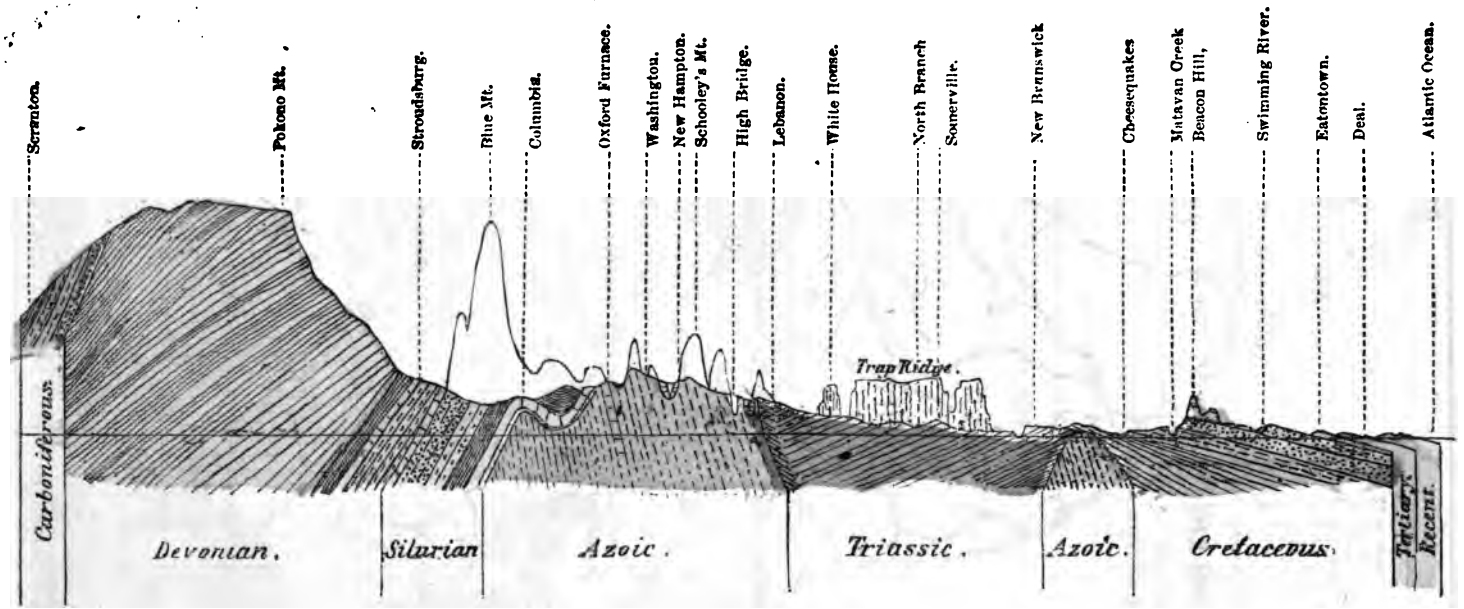
GEO. H. COOK, *Geologist.*


Rantan R.
Shark River
Delaware R.
Cape May
GEOLOGICAL
MAP
OF
New Jersey.
GEO. H. COOK.
1. Azoic,
2. Silurian
3. Devonian,
4. Carboniferous,
5. Triassic,
6. Cretaceous,
7. Tertiary,
8. Recent.

Geological Section from Shark River Inlet, N. J. to Scranton, Penn.

BY GEO. H. COOK.

Horizontal Scale, 16 miles to 1 inch. Vertical Scale, 1600 feet to 1 inch.



Tabular Statement to accompany the preceding Map and Section, giving the Geological Periods represented in New Jersey.—the principal rocks in the order of their occurrence, beginning with the lowest,—and some localities where the rocks may be seen.

1. AZOIC.

GNEISS AND SYENITE—Highland range of mountains and the rock at Trenton.

WHITE LIMESTONE—Vernon, Hamburgh. Franklin Furnace, Sparta, Audover, Jenny Jump Mountain, Oxford, Roxburgh.

MAGNETIC IRON ORE—Mines at Ringwood, Mount Hope, Succasunny, Oxford, and many others.

ZINC ORE—Sterling Hill and Mine Hill.

CONGLOMERATES AND SANDSTONES—Green Pond Mountain, Bearfott Mountain, and Copperas Mountain.

2. SILURIAN.

SANDSTONE—Franklin and Oxford Furnaces, and near Mount Bethel.

BLUE LIMESTONE—Valleys of Warren and Sussex Counties.

SLATE—Kittatinny and Longwood Valleys.

CONGLOMERATE—Blue or Shawangunk Mountain.

RED SANDSTONE—Northwest slope and foot of Blue Mountain.

GRAY SANDSTONE—Valley of the Delaware, above the Water Gap.

LIMESTONE—Valley of the Delaware, above the Water Gap.

3. DEVONIAN.

SANDSTONE—Valley of the Delaware, from Walpack Bend to Port Jervis.

LIMESTONE—Valley of the Delaware, from Walpack Bend to Port Jervis.

SHALE—Valley of the Delaware, from Walpack Bend to Port Jervis.

4. CARBONIFEROUS.

Not represented in New Jersey, but found in the adjoining parts of Pennsylvania.

5. TRIASSIC.

RED SANDSTONE—Paterson, Little Falls, Belleville, Newark, Trenton, and Milford.

RED SHALE—Everywhere in (5.) See Map.

BASALTIC OR TRAP ROCK—Bergen Hill, Palisades, Sourland Mountain, Rocky Hill, Range from Pluckamin to Paterson, &c.

6. CRETACEOUS.

FIRE AND POTTERS' CLAYS—Perth Amboy, Woodbridge, South Amboy, and Trenton.

DARK COLORED CLAY AND LIGNITE—Shore of Raritan Bay, Cheesequakes, ane Bordentown.

CLAY AND GREENSAND, "SPURIOUS MARL"—Matavan, Crosswicks, and Kincora.

GREENSAND, "FIRST MARL BED"—Nevesink Highlands, Middletown, Freehold, Cream Ridge, Shelltown.

FERRUGINOUS SAND—Red Bank Monmouth County, Mount Holly, ullica Hill, &c.

GREENSAND, "SECOND MARL BED"—Blue Ball, New Egypt, Pemberton, White Horse, Barnsboro', Woodstown, &c.

TERTIARY.

GREENSAND, "THIRD MARL BED," (EOCENE)—Deal, Shark River, Squankum, New Egypt, Pemberton, and Clementon.

CALCAREOUS MARL, (MIOCENE)—Jericho, Shiloh, Woodstown, and south of Mullica Hill.

LOAMY GRAVEL AND SAND—Central and Southern New Jersey.

RECENT.

ALLUVIAL LOAMS AND SANDS—Margin of upland along tide-water.

BEACH SANDS—Beaches of Sandy Hook, and the Atlantic Shore.

TIDE MARSHES—Newark and Hackensack Meadows, Salt Meadows along the Sea, and Delaware Bay Shores.

SWAMPS AND WET MEADOWS—Cedar Swamps, Long Meadow, Whippany and Passaic Meadows.

ANNUAL REPORT

OF

PROF. GEO. H. COOK, STATE GEOLOGIST,

TO

HIS EXCELLENCY JOEL PARKER,

PRESIDENT OF THE BOARD OF MANAGERS

OF THE

GEOLOGICAL SURVEY OF NEW JERSEY,

FOR THE YEAR 1865.

TRENTON, N. J.:
PRINTED AT THE "STATE GAZETTE" OFFICE.
1866.

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STATE OF NEW JERSEY,
EXECUTIVE DEPARTMENT, January 10th, 1866.

To the Senate and General Assembly:

By the act of the Legislature authorizing the completion of the Geological Survey of the State, which was approved March 30th, 1864, it becomes my duty to submit to the Legislature the anuual report of the State Geologist upon the progress of the work, together with the expenses attending it. The report is herewith submitted.

The act appointed a Board of Managers, consisting of the Governor of the State as President, and two persons from each Congressional District as members, who, with the State Geologist, have the management of the survey, and direct the publication of its results.

Board of Managers:

His Exeellency JOEL PARKER, (President).
Gen. DAVID POTTER, of Cumberland.
Hon. ANDREW K. Hay, of Camden.
Hon. WILLIAM PARRY, of Burlington.
JOHN A. ROEBLING, Esq., of Mercer.
ISAAC B. CORNELL, Esq., of Somerset.
HENRY AITKIN, Esq., of Union.
Hon. ANDREW B. COBB, of Morris.
ABRAHAM S. HEWITT, Esq., of Passaic.
WILLIAM M. FORCE, Esq., of Essex.
Hon. JACOB R. WORTENDYKE, of Hudson.

The Board has held regular meetings, at which the progress of the work has been shown, and the plans for its continuance presented. The accounts have all been audited by a committee of the Board.

At the last meeting the Geologist was directed to proceed with the publication of the map and report upon the marl district of the State, and some of the results of the survey will soon be ready for distribution.

JOEL PARKER.

To His Excellency Joel Parker, President of the Board of Managers of the Geological Survey of New Jersey:

SIR: I have the honor herewith to submit my report upon the operations of the State Geological Survey for the present year.

Your obedient servant,

GEO. H. COOK,
State Geologist.

New Brunswick, N. J., Dec. 26, 1865.

REPORT.

The work upon the geological survey has been steadily prosecuted through the entire year. Mr. John C. Smock, Assistant Geologist, was engaged in the chemical and mineralogical examination of rocks, minerals, and other useful substances during the last winter. With the opening of spring, he began the survey of the trap ridges in the red sandstone district, and continued it through the month of June. Since that time he has been engaged in the marl district, verifying the work of the survey of 1854-5-6, and carrying it out with greater minuteness of detail. Professor David Murray was occupied for some time last winter and spring in collecting and arranging all the geographical positions which had been previously determined in the State. During the summer, he connected the eastern end of the New York and New Jersey State line with the United States Coast Survey, and determined its latitude and longitude. He has also made considerable progress in triangulating, for the correction of the State geological map, and finished a few computations. Mr. Paul Cook was engaged with Professor Murray in his work. G. M. Hopkins, Civil Engineer, has made a careful survey and plotted upon a large scale, about eighty square miles of territory in Morris county. This includes the largest iron mines of that county. He was assisted in the field by Mr. Edward H. Latch, and in mapping by Mr. S. B. Linton. Mr. Hopkins has also compiled from various sources, and drawn a map of the greensand marl district in the counties of Monmouth, Ocean, Burlington, Camden, Gloucester and Salem. Dr. Chas. C. Abbott has spent some time in continuing his catalogue of the vertebræ animals of New Jersey. From the United States Coast Survey, through J. E. Hilgard, Esq., Assistant in charge of the office, there has been furnished descriptions of all triangulation stations they have occupied in the northern half of the State; together with diagrams of the several locations. My own time has been partly taken up with the work mentioned above, and partly in studying out the geology of districts which must next be surveyed in detail.

The results of the survey during the past year are as follows:

1. A geological map and sections of the cretaceous formation, including the greensand marl beds. It also includes the fire and potter's clay beds. The different strata are traced upon the map, as they appear upon the surface; and they are shown in thickness, dip and relative position in the different sections. The map is upon a scale of two miles to an inch, and includes an area of about two thousand square miles. The descriptive matter to accompany this map is collected, a large number of chemical analyses are completed, and the whole work so far advanced that it is expected the final report will be ready for publication in the course of the winter.

2. A topographical survey and map of part of the iron-ore district of Morris county has been completed. This map has been drawn upon a scale of six inches to one mile. It covers about eighty square miles, and upwards of sixty different iron mines are located upon it. The heights of hills along the veins of iron-ore have been found by leveling, and the hills are defined by level contour lines drawn along their surface for every twenty feet of rise. The fields of cultivated land are also shown and the woods. There is still needed to complete the map, a magnetic survey of the direction and extent of the veins of iron ore that are now worked. If means will allow, the contour lines may be surveyed and drawn over the whole map. Sections and plans of some of the principal iron mines are also to be drawn. There is still other field work in geology to be done upon the district embraced by this map before it will be ready for publication.

3. A partial report, with map and sections of the Green Pond Mountain rocks is in preparation. These rocks have heretofore been the subject of much study and speculation. They form a long and narrow range of mountain ridges of conglomerate, sandstone and shale, bounded on both sides by the gneiss rocks of the Highlands. They contain but few fossils or other marks for determining their age or position in the geological series. The sections which have been made show that they lie directly, but unconformably, upon the gneiss. Fossils of the Trenton Age are found at a few localities, lying in a synclinal valley of these rocks, and probably upon them. From these facts it may fairly be concluded that the rocks in question are among the lowest in the series of sedimentary or fossiliferous formations. Full and detailed sections of heights and of rock structure will be prepared before publication.

4. A very large collection of heights above the level of the sea, of places in various parts of the State, has beer obtainedfrom our own observations, and from the various railroad and canal surveys. These will be used in constructing geological maps and sections. They will also be useful in illustrating the physical geography of the State, and in furnishing information relating to the location of roads, railroads, canals, and works for water power and for drainage. The sources from which these heights have been ascertained are given in the tables. There are one thousand of these, including the heights of mountains, mountain gaps, canal levels, railway summits and sta-

tions, bridges, streams, &c., all of which can be easily identified. It is designed to extend this as far as possible in the further progress of the survey.

5. The true latitude of the monument at the east end of the State line between New Jersey and New York, has been determined by making it a triangulation point, and connecting it with well known stations of the United States Coast Survey. This line was originally marked by stone monuments set in the ground at the end of every mile. The line was run in the summer of 1774. Since that time some of the posts have been lost, and of others it is asserted that they have been moved. As it becomes important in describing and locating iron mines and other valuable property along the boundary, it is necessary to have the line itself reliably defined. It is as a beginning of this work that the geographical position of the starting point on the Hudson has been again ascertained, and if means will allow, the whole line will be resurveyed.

The point agreed upon by the Commissioners who settled the boundary between the two States for the east end of the line, was on the west bank of the Hudson river, in latitude 41° north. The latitude was determined from astronomical observations by the eminent astronomer David Rittenhouse. It is about a mile below Sneden's Landing, and is marked upon a heavy block of stone. which lies upon the bank of the river, just at high-water mark. It is undoubtedly in the place where it was originally set. Our calculations make it to be in latitude 40° 59' 47".78, and in longitude 73° 53' 51".25. This varies from the determination of Mr. Rittenhouse by 12."22, or about 1,237 feet. This result does not, however, discredit the accuracy of Mr. Rittenhouse's work. Similar discrepancies between the results of astronomical observations, and geodetic surveys have been frequently observed both in our own and in foreign countries: and they are too well known to he attributed to errors of observation or measuremeht, though the cause is not fully understood.

6. In reviewing the triangulation of the northern part of the State, which was done in 1854–5-6, the following geographical positions and distances have been satisfactorily determined, using the United States Coast Survey line between Springfield and Mount Rose as the base:

LATITUDES, LONGITUDES, AZIMUTHS AND DISTANCES.

Stations.	Latitudes.	Longitudes.	Azimuth.	To Station.	Distance in Metres.	Distance in Feet.	Distance in Miles.
Springfield.	40° 41′ 19″.44	74° 21′ 05″.44	41° 07′ 46″.1	Mount Rose.	47,366 7	155,410 15	20.43
Mount Rose.	40° 22° 00″.56	74° 43′ 06″.14	220° 53′ 27″.8	Springfield.	47,366 7		
Mine Mount.	40° 43′ 17″.45	74° 38′ 23″.33	279° 43′ 16″.07	Springfield.	21,323 18	69,961 35	13.25
			99° 54′ 34″.25	Back Azimuth.			
Mine Mount.			14° 16′ 56″.03	Mount Rose.	40,642 05	133,346 57	25.25
			194° 13′ 55″.91	Back Azimuth.			
Walnut Grove.	40° 50′ 24″.08	74° 34′ 21″.85	311° 53′ 53″.54	Springfield.	25,120 34	82,419 83	15.609
			132° 02′ 33″.55	Back Azimuth.			
Walnut Grove.			9° 59′ 00″.24	Mine Mount.	13,561 32	44,494 69	8.302
			189° 56′ 22″.07	Back Azimuth.			
Boonton.	40° 55′ 06″.73	74° 14′ 04″.47	350° 39′ 02″.65	Springfield.	25,859 12	84,843 77	16.06
			107° 40′ 59″.55	Back Azimuth.			
Boonton.			58° 57′ 48″.55	Walnut Grove.	16,880 88	55,386 16	10.48
			238° 51′ 5″.44	Back Azimuth.			

7. The geographical positions determined by the United States Coast Survey, within the bounds of New Jersey, have been copied out from the various reports in which they have been published, and are arranged for use in constructing maps.

The descriptions and marks of the different stations occupied by the Coast Survey in the northern half of the State, have been copied out from the records of the office and sent to us.

The officers of the United States Coast Survey have rendered material aid to the Geological Survey by the free use of their theodolites, and by their prompt and hearty response to all applications for information relating to their work or records.

8. The catalogue of vertebrate animals of the State, has been continued by Dr. Charles C. Abbott, of Trenton.

EXPENSES.

At the annual meeting in December, 1864, the Survey had been in operation only nine months, and the accounts then audited amounted to---------- $1,198 64

The bills for the remaining three months of the year were audited by your committee, Messrs. Hewitt and Aitkin, and amounted to---------- 1,076 08

Making, for the first year, a total of---------- $2,274 72

Which is less than half the $5,000 appropriated.

The expenses this year are as follows:

For the quarter ending June 30---------- $1,173 49

" " " September 30---------- 2,221 84

These have been audited by the committee and paid by the State Treasurer.

The bills for the quarter ending December 31, amount to- 1,063 29

$4,458 62

The act of the Legislature of 1864, for completing the Geological Survey of the State (Laws of New Jersey, chap. 337, p. 591), required the "survey to be completed within a period not to exceed four years, and at an expense not to exceed the sum of twenty thousand dollars, aside from the cost of publication." It is intended to keep the expenses of the work within the appropriation, and to complete the survey in the time set.

PLAN OF PURSUING THE WORK STILL TO BE DONE.

In the further prosecution of the survey it is proposed to finish the work in sections, like that of the cretaceous formation which is now presented. The red sandstone formation which lies directly northwest of the cretaceous will be finished in the course of the year; and following that, the large district which lies to the southeast of the

cretaceous, and includes all the southern part of the State, will be completed. The northwestern portion of the State, comprising that which is most intricate in its geological structure will be the last done.

The great natural advantages of our State, in its nearness to the best markets of the country, in the remarkable adaption of its soil to the most productive agriculture in its great mineral wealth, in its immense water power, and in its mild and healthy climate are beginning to be appreciated. At no time during the history of the State has population increased so rapidly, industrial enterprise been so extensive and successful as now, nor has the value of property ever before increased so fast. Everything that can be done to develop our resources, and make them more fully known, helps forward these interests of the State. The Geological Survey which is devoted to these objects, has met the hearty approval and co-operation of our citizens. The names of those who in their public or private capacities have contributed aid and information to the work would make too long a list for this report; it would be invidious to single out from among them, and I must therefore, in general, express to those friends the thanks of my assistants and myself; as I know I do also of the board of managers, and of yourself their president, for the many favors received.

GEO. H. COOK, *State Geologist.*